

ART. VII.—Notes on *Coptotermes bornensis* Oshima (*Isop-
tera*). A Study in Description of the Termite Soldier.

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Termitologists have long felt the need of a more satisfactory method of determining and expressing the characters of the soldiers of termite species. Experience of students of the group, written and orally expressed, has been accumulating to show that the general part of most descriptions of species, and especially of the soldiers, deals mainly with generic characters, or characters common to numerous species, with characters of an extremely variable nature, or with characters of a nature such as to prevent their clear expression in words, and that with few exceptions the characters of practical importance in differentiating species are those of shape, size, and proportions of hard parts, chiefly the head, mandibles, gula, fontanel, pronotum, and perhaps the labrum and leg segments. Characters of proportion lend themselves to a mathematical expression (Light, 1927). Characters of shape call for a certain amount of description in words, and demand illustrations to overcome the limitations of language, yet they also may all be expressed in part, at least, by indices of relative proportions.

Since, therefore, the characters of practical importance in such work depend upon measurements, it becomes of primary importance, if these measurements and the values derived therefrom are to be helpful and not actually misleading, that the terms applied to dimensions of parts be accurately defined, and that these definitions be given in unmistakable form by all workers in the field until some general agreement has been arrived at. The importance of this point cannot be over-emphasized, and Light (1921) and Emerson (1925) have set a precedent in this regard which must be followed by all workers in the field if confusion and error are to be avoided.

Further, there has often been an unfortunate lack of diagnoses and even of comparisons with closely related species in papers on termite systematics which has rendered all the more difficult the work of those who followed after. Such diagnoses and comparisons of species give the real reasons for the erection of the species, reasons which are often quite lost in the ordinary description.

In a recent paper Light (1927) has called attention to these conditions, and proposed the extensive use of indices of proportions of parts as the only means of putting the systematics of the group on a workable basis. At the suggestion of Dr. Light I

have attempted a redescription of *Coptotermes bornensis* Oshima with the above points in mind. An attempt has been made to eliminate extraneous elements from the description, and yet to give all the material available for systematic purposes at this time. Following the description is an attempt at a criticism of the original description in the light of the newer methods exemplified. *Coptotermes bornensis* was chosen because paratypes of this species presented by Dr. Oshima were available in the collection of Dr. Light, thus making possible a redescription. Any one of a number of descriptions by any one of several authors might have been chosen to point the moral.

Methods.

Measurements were made from both alcoholic and mounted specimens. The latter give greater accuracy, but unmounted specimens if carefully oriented allow for sufficiently accurate measurement. When mounts were made mouth-parts and gula were dissected out and mounted with the head.

A method of embedding in celloidin, for which I am indebted to Mr. Albert E. Galigher, of Berkeley, California, is extremely well suited to this type of work, and directions for its use follow.

The parts to be mounted, dissected out in alcohol under the binocular dissecting microscope, are placed in a small, flat-bottomed dish, such as a Syracuse watch-glass or a two-inch Petri dish. Drain off the excess alcohol and pour in enough 2% celloidin to cover them. They may then be arranged as desired. If the celloidin should become too hard before this is accomplished, two or three drops of ether-alcohol may be poured over the objects. This will soften the celloidin in that region, and allow for further manipulation. The objects having been arranged, the celloidin is allowed to harden on top, and a little chloroform poured into the dish and allowed to stand for some time. This hardens the celloidin sufficiently so that a sheet of the desired size may be trimmed out and transferred to carbol-xylol to clear. It is then placed in xylol for a few minutes, put on a slide with balsam, and covered. Mounts of this sort are permanent, and the objects are fixed in position, with no possibility of their tipping or getting out of arrangement.

All examinations were made under very low powers of the compound microscope, and measurements were made by means of an ocular micrometer scale. Drawings were made with a projection apparatus, except that of the side view of the head, for which material for an extra mount could not be sacrificed, and which was therefore drawn to the same scale with a camera lucida.

Measurements and Values.

The characters of the dimensions of the fontanel aperture and the angle of inclination have not heretofore been used. In some

species they may be so nearly the same as to be valueless, yet in many cases, as in the present, these two characters do have a definite value in diagnosis. In measuring the angle of inclination, the head is placed upon its side, and an ocular protractor or goniometer is used. The base line is set from the lower edge of the fontanel to the most posterior point of the head. In most cases this will closely parallel the dorsal profile. The angle of inclination from the vertical may then be easily measured. The dimensions of the fontanel aperture are measured with an ocular micrometer, the head being at the proper angle to bring the fontanel rim on a level all round.

The fontanel index as defined by Light (1921) has not been used since, as pointed out by him (1927), it presents certain difficulties of measurement for the *Coptotermes* soldier, and, due to the large size and inclination of the fontanel aperture, really involves two variable factors, the relative location of the fontanel and degree of inclination of its aperture. It will doubtless prove of great value in other genera possessed of a small fontanel.

The fontanel aperture index, hereafter referred to as aperture index, as used here, is the fractional result of dividing the average maximum fontanel length (longitudinal or vertical diameter of the fontanel aperture) by its average maximum breadth (transverse diameter). The aperture, which shows white in contrast to the darker margin, alone is measured.

The length of the left mandible is measured in dorsal view, from the posterior margin of the condyle in a straight line to the apex of the mandible.

The pronotal index is the average maximum breadth divided by the average of average minimum and average maximum length.

All other measurements are as defined by Light (1927), and values are derived as follows:—

Head index=Maximum breadth divided by length.

Head contraction index=Minimum breadth divided by maximum breadth.

Gular index=Gular length divided by average gular breadth.

Gular contraction index=Minimum breadth divided by maximum breadth.

Gular maximum breadth index=Gular length divided by maximum breadth.

Gular minimum breadth index=Gular length divided by minimum breadth.

Pronotal index=Maximum breadth divided by average length.

Light (1927) has shown the most significant of these to be head contraction index and gular contraction index.

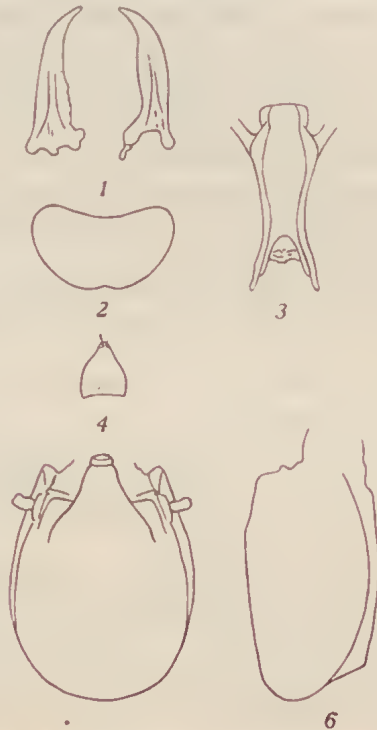
COPTOTERMES BORNENSIS Oshima.

C. bornensis Oshima, 1914, Annot. Zool. Japonenses, vii., pp. 556-7, pl. ix., fig. 2.

Diagnosis.

Alate unknown.

Soldier.—Of medium size for the genus, head averaging 1.25 mm. in length and 1.03 in maximum width; head contraction index 0.68; fontanel distinctly tubular and extending beyond the level of the anterior angles of the head, i.e., fontanel index 1+; fontanel aperture small (0.089×0.096 mm.), nearly round, aperture index ca. 0.93; very nearly upright with an inclination of but 2° - 5° from the vertical; right mandible thickened in middle third; gular index 2.58; contraction index 0.51; maximum breadth index 1.95; minimum breadth index 3.8, pronotal index 2.14.



FIGS. 1-6. *Coptotermes bornensis* Oshima $\times 24$.

1. Mandibles, dorsal view; 2. Pronotum; 3. Gula, ventral view; 4. Labrum, dorsal view; 5. Head capsule, dorsal view; 6. Profile of head.

Description.

Soldier.—Colour as usual for the genus.

Vestiture of large and small, stiff white hairs. A few scattered erect bristles on head; dorsal sclerites with rather dense pubescence, the larger hairs arranged in a row along the posterior margin of each, and a second incomplete, irregular row within; smaller hairs scattered irregularly over the disc. Pubescence finer and more dense posteriorly.

Head is of the shape shown in Fig. 5, oval in dorsal outline, sides converging anteriorly. Fontanel tubular, the tube starting well back on the head, and the sides converging anteriorly to form the heavy chitinous border of the fontanel, terminating approximately 0.1 mm. anterior to the anterior angles of the head; fontanel aperture nearly round, and directed forward at an angle of from 2 to 5 degrees from the vertical. Chitinous upper rim of the antennal fovea heavy and thick, prominent posteriorly, less so anteriorly. Within this and median to it runs a parallel ridge, interrupted just forward of the anterior edge of the fovea, then turning inward at about a right angle to parallel the mandibular articulation for a short distance; median to this ridge a second, smaller ridge, subparallel to it (Fig. 5).

Antennae, 13-jointed in the specimens studied; second joint cylindrical, nearly square in outline as viewed from the side, smaller in diameter, and half as long as the first; third joint, in specimens examined, equal to the second in length, but somewhat pear-shaped; fourth joint subequal to or shorter than the second, pear-shaped, the small end basal, widest at the apical third. Joints 5-8, increasing successively in size, pear-shaped, pedunculate, ("stem" end basal); joints 9, 10 and 11 equal in length to 8; joint 12 somewhat longer, 13 subequal to 12, but smaller in diameter, subovate, and widest at the basal third.

Labrum of the shape shown in Fig. 4; hyaline tip distinct, colorless, triangular in dorsal view, with a rounded apex.

Left mandible sharp, curved at the tip, dark mahogany brown or blackish in colour; denticulation amounting to little more than crenulation, three very small teeth and a large basal tooth (Fig. 1). Right mandible untoothed, very characteristic in shape, somewhat shorter, blunter, and less curved at the apex than left mandible; inner cutting edge of the mandible swollen just back of the apex (Fig. 1).

Gula with somewhat globular anterior portion (Fig. 3).

Pronotum (Fig. 2) with the anterior margin broadly, concavely arcuate; antero-lateral angles broadly, evenly rounded; postero-lateral and posterior margins are smoothly, evenly rounded, a very slight, obtuse emargination in the mid-line.

MEASUREMENTS AND INDICES.

	Indices		Measurements		
			Maximum	Minimum	Average
Head					
length with mandibles	—	-	—	-	1.961
length - - - - -	—	-	1.327	-	1.256
length to fontanel - - -	—	-	1.341	-	1.293
maximum breadth - - -	—	-	1.038	-	1.026
minimum breadth - - -	—	-	0.717	-	0.702
index - - - - -	0.818	-	—	-	—
contraction index - - -	0.684	-	—	-	—
Gula					
length - - - - -	—	-	0.750	-	0.731
maximum breadth - - -	—	-	0.392	-	0.377
minimum breadth - - -	—	-	0.199	-	0.193
average breadth - - -	0.260	-	—	-	—
index - - - - -	2.576	-	—	-	—
contraction index - - -	0.512	-	—	-	—
maximum breadth index	1.947	-	—	-	—
minimum breadth index	3.803	-	—	-	—
Head length divided by					
maximum gular breadth	3.332	-	—	-	—
minimum gular breadth	6.508	-	—	-	—
average gular breadth -	4.407	-	—	-	—
gular length - - - - -	1.711	-	—	-	—
Fontanel					
length - - - - -	—	-	0.095	-	0.089
breadth - - - - -	—	-	0.099	-	0.096
angle of inclination - -	2°-5°	-	—	-	—
aperture index - - - -	0.927	-	—	-	—
Labrum					
length - - - - -	—	-	—	-	0.293
length with hyaline tip	—	-	0.313	-	0.276
maximum breadth - - -	—	-	0.258	-	0.240
Pronotum					
maximum length - - - -	—	-	0.383	-	0.367
minimum length - - - -	—	-	0.303	-	0.295
maximum breadth - - -	—	-	0.731	-	0.717
index - - - - -	2.140	-	—	-	—
Length of hind tibia - -	—	-	0.783	-	0.767
Length of left mandible -	—	-	0.891	-	0.863
Total length of insect -	—	-	3.8	-	3.7
Length of antenna - - -	—	-	1.229	-	1.091

Description drawn from three soldiers collected by Mr. Ryozo Kanchira at Balik-Papan, Dutch Borneo, April 20, 1913. These specimens, paratypes from Oshima's type material, are in the collection of Dr. Light, No. 330B.

The averages given are the averages of the three specimens. Maximum is the largest measurement of the particular part, and the minimum the smallest. The only exception is the average gular length, which is the average of the average minimum and average maximum lengths.

The foregoing description, while by no means complete, includes all of the points covered in the original, with some additional information, yet if the measurements were not included, I very much doubt that anyone could identify the species from

it with any degree of certainty. Color is unsafe to depend upon. Vestiture may vary considerably, and has not been well described by many termitologists. The antennal characters, while apparently thought much of, are subject to so much variation as to be virtually useless. The number of segments and their relative size in the region of the third joint differ between individuals of the same colony. The same objection applies to body length in even greater degree, since this is subject to fluctuation according to the amount eaten, loss of cephalic gland secretion, etc. It will be seen, then, that the general facies of the termite soldier is not a safe guide to diagnosis. There remain the shape of the head, pronotum, mandibles, and gula, and the proportional measurements, and these are the essential parts of the description. The labrum is of minor importance, its significance not having been worked out, but the measurements may be useful in some cases.

In addition to all the above difficulties, the usual description is couched in such vague terms as to make identification extremely difficult. For example, to quote Oshima: "Head oval, vaulted dorsally, . . . fontanelle directed forward." In dorsal view the head is oval enough to allow the use of this term. When viewed from either end the head is evenly rounded dorsally, perhaps enough to merit the term vaulted. In profile, however, the head is decidedly flattened dorsally, as shown in the figure. "Fontanelle directed forward" is true enough, but means little. The fontanel is directed forward and the dorsal edge of it is 0.1 mm. in advance of the antero-lateral angles of the head, as will be seen from the measurements. The tube-like process of the fontanel is rather peculiar, being conspicuous and terminating in a little separate margin for the orifice. The angle of inclination is also characteristic. "Pronotum slightly longer than one-half the width, anterior border strongly indented at the middle, posterior border slightly emarginate at middle. . . . The term "indented" means little. I take it that this means that the anterior margin is slightly, obtusely emarginate, at the mid-line, but there is nothing to indicate that this is the case. It might just as well mean the whole arcuate anterior margin. There is, in the specimens at hand, no perceptible emargination of the anterior margin. At the mid-line, however, there is an indentation of the dorsal surface that at first glance appears to involve the anterior margin, but actually does not do so. Perhaps it is to this that Oshima refers. The term "slightly emarginate" is correct, but the shape of the emargination is not specified. It might be rounded at the bottom, acute, or obtuse. Actually it is a slight, obtuse emargination, fairly sharp at the bottom.

The measurements of Oshima agree fairly closely with mine, except that the length of the pronotum is given as 0.41 mm. I have 0.295 mm. along the mid-line, and 0.367 mm. from the most posterior to the most anterior points. If Oshima has given the latter measurement the discrepancy is less, but I understand that

this is not the common practice, and he does not state which was used. In case the length along the mid-line is given, there must be some error in his measurements, as I have carefully checked mine.

A point that evidently escaped Oshima's notice is the peculiar shape of the right mandible, which appears to be characteristic of this species.

Oshima considers *Coptotermes travians* Haviland to be the most closely related of described *Coptotermes* species, the new species differing in a more contracted gular and in having but 13 antennal segments. Without the alates he felt it difficult to differentiate the two species. Yet a careful comparison shows distinguishing characters to abound, some of rather a striking nature, unusual in the genus, such as the tubular fontanel, very slight angle of inclination and swollen right mandible of *C. bornensis*. Others are brought out by the indices of proportions proposed by Light (1927) and used in the preceding description.

Below is given a comparative table showing in parallel columns the indices for *C. bornensis* and *C. travians*. Those for *C. bornensis* are based on measurements of but three specimens, and those for *C. travians* on measurements for but one from Singapore, identified by Holmgren, No. Si 365 in Dr. Light's collection. These are subject to considerable revision when more data are available. While the two species show a surprising correspondence in most of these indices, significant differences are to be noted, particularly in pronotal index, fontanel aperture index, and fontanel index.

	<i>Coptotermes bornensis</i>	<i>Coptotermes travians</i>
Head index - - - - -	0.818	0.812
Head contraction index - - - - -	0.684	0.622
Gular index - - - - -	2.576	2.575
Gular contraction index - - - - -	0.512	0.535
Maximum gular breadth index - - - - -	1.947	1.976
Minimum gular breadth index - - - - -	3.803	3.695
Pronotal index - - - - -	2.140	1.980
Fontanel aperture index - - - - -	0.927	0.874
Head length divided by—		
Maximum gular breadth - - - - -	3.332	3.454
Minimum gular breadth - - - - -	6.508	6.458
Average gular breadth - - - - -	4.407	4.501
Gular length - - - - -	1.711	1.747
Fontanel index - - - - -	1 +	0.890

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